BERING SEA ECOSYSTEM

WORKSHOP REPORT

Anchorage, Alaska

June 2-3, 1998

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Introduction

On December 4 and 5, 1997, the National Oceanic and Atmospheric Administration (NOAA), the U.S. Department of Interior (USDOI), and the Alaska Department of Fish and Game (ADF&G) sponsored a Bering Sea Ecosystem Workshop in Anchorage, Alaska. The purpose of the workshop was to promote research coordination and data sharing among organizations that study, manage, and utilize resources of the Bering Sea. One of the recommendations of the workshop led to the development of an integrated Bering Sea ecosystem research plan.

Scientists from NOAA, the DOI, and ADF&G completed a first draft of this research plan on April 24, 1998. This draft was distributed for broader review and consideration by other groups involved in the Bering Sea and a second Bering Sea Ecosystem Workshop was held on June 2 and 3, 1998 in Anchorage, Alaska to receive further input on the research plan from these other groups. This report summarizes the discussions that took place at this workshop.

Opening Plenary Session

The meeting began with the following remarks from representatives of the U.S. Department of Commerce/National Oceanic and Atmospheric Administration (NOAA), Alaska Department of Fish and Game (ADF&G) and U.S. Department of the Interior (DOI).

STEVE PENNOYER, ALASKA REGIONAL ADMINISTRATOR, NATIONAL MARINE FISHERIES SERVICE

These planning efforts for the Bering Sea began about a year and a half ago among the Department of the Interior, Alaska Department of Fish and Game and NOAA. Discussions revolved around the importance of the area, the importance of an initiative that would bring people together, and the need to discuss what we don't know, do know and what data we need. That was because of our recognition of the importance of the Bering Sea and all of the reasons that we consider it to be an unparalleled national treasure. It produces as much groundfish as the whole rest of the United States put together out of the EEZ. It has unparalleled populations of marine birds and marine mammals that have international as well as national significance and the list goes on and on.

The White Paper that was originally produced by Interior and then was edited by NOAA and Fish and Game and the North Pacific Fisheries Management Council goes into the whole discussion of the various resources in the Bering Sea, with an emphasis on the need for coordination and planning and communications between participants who do research and management in this area. That discussion led to that last workshop this past December. The purpose of that workshop was to discuss the extent of our knowledge in the Bering Sea. It was to review what we're doing now and then to discuss the data gaps that may need to be resolved before we can really manage that ecosystem or ensure its continuity. A steering committee was formed and the groups primarily from the three agencies mentioned have gotten together with others and have come up with a draft research plan, which is the document being reviewed at this workshop. Several months of very intense work over the last six months, led to that draft. The draft is now being exposed to a broader constituency in order to finalize it.

The National Marine Fisheries Service is a resource management agency that manages many of the resources in the Bering Sea. The 30 year history of five billion pounds a year continuous harvest from groundfish are an example of good management in that area given our knowledge extent. Nevertheless, there are a lot of things that have happened over the last years and changes that we can't attribute yet directly to any specific action by humans or specific climate or ecosystem change. But these are indicators of things that we need to understand to manage for the future. There is a real need for predictability. We have to get out there and decide what we can manage and what we can't manage and then try to do it.

We had several recommendation from the last workshop. There was a recommendation that we create a metadatabase for the Bering Sea. That has been initiated and is ongoing. The recommendations to create websites and to start better and broader research coordination for research planning have been acted on and are ongoing. Another recommendation was that we try to find ways to incorporate traditional and local knowledge into the management process and science process. That discussion is continuing and there are a lot of different venues that are trying to deal with that very significant issue. Lastly, there was a recommendation that we create a science plan. That is the draft being presented here and that we hope you will get a chance to dig into fairly deeply at this meeting. Too often strategic plans and all of our experience or reviews sit on a shelf and gather dust and they serve as historical reference points and do little more. That is not the intent here. Our intent is that this document be updated as we acquire new knowledge, that the effort, including workshops such as this, continue and that the collaboration and communication that we're trying to foster here continue as well.

At the last workshop we talked about the North Pacific Research Board. This was formed by recent legislation sponsored by Senator Stevens. It deals with the Dinkum-Sands money and has a fairly guaranteed income flow of $5-10 million a year. This board is supposed to basically form a grants process for research in marine waters off Alaska in the North Pacific, the Bering Sea and Arctic Ocean. The board is not in place yet but will probably be formed by early 1999 at the latest. There's no appropriation yet and there have been discussions of the board membership and what may happen in that direction. So we're still in a state of flux. Originally, this document was not prepared for the board. We started talking about the Bering Sea initiative well before the board was a gleam in some of our eyes. But what you've done here would serve as one of the strategic documents for this group to consider as they deal with priorities in granting money for research off Alaska.

Another item I'd like to mention is that this effort is also achieving interests at the highest levels of government and I think you're going to see a collaboration by the State of Alaska, the Department of Commerce and the Department of Interior to sponsor a FY2000 budget initiative on the Bering Sea to provide additional funding to whatever may be available under Dinkum-Sands to get the effort started. We would use this plan as a basis for that. The Exxon Valdez and the Oil Spill Trustee Council is looking at a restoration reserve. This restoration reserve would be used for a number of processes as yet not totally determined, but probably including ecosystem research and monitoring in the Gulf of Alaska, largely to do with resources damaged by the Exxon Valdez oil spill. But obviously the linkages, the area overlaps the North Pacific Research Board. The research linkages in terms of understanding ecosystems are fairly obvious and there's a very major area of ability to collaborate on planning and coordination on that.

DEBORAH WILLIAMS, SPECIAL ASSISTANT TO THE SECRETARY FOR ALASKA, DEPARTMENT OF THE INTERIOR

There are four recommendations from the December workshop, which can be found in the workshop proceedings. We are moving forward with implementation of these recommendations and are making very positive forward progress on coordinating research effort in the Bering Sea. People in Washington, D.C. are enthusiastic about bringing more money for research to the Bering Sea. The more work we do to focus on the Bering Sea, the more people from other parts of the country will begin to understand that this is the greatest marine ecosystem in the United States and we need more research to understand and to protect that ecosystem. We are here today to focus on research needs and to focus on how we can collaborate with traditional knowledge to best understand the Bering Sea, so that ultimately resource managers can make the best management decisions.

We have encouragement at the top, tremendous initiative of the implementers and enthusiasm all the way through, because we all know the Bering Sea deserves this continued effort. I want to recommend that we all let the outside world know how important this ecosystem is and how it needs more money to protect it. We want to be able to tell our parents, children and grandchildren that we were a part of making sure that this ecosystem retained its biodiversity for posterity. We want to say we ensured the survival of the birds and animals, and sustained the livelihoods and cultures of indigenous peoples reliant on the Bering Sea.

DOUG EGGERS, CHIEF FISHERIES SCIENTIST, ALASKA DEPARTMENT OF FISH AND GAME

On behalf of Frank Rue, the Commissioner of the Alaska Department of Fish and Game, I welcome you to the workshop on the Bering Sea Ecosystem Research Plan. I certainly don't have to reiterate the importance of the Bering Sea ecosystem and the renewable resources supported there to the coastal communities and to the state, as a whole, who depend on these resources for sustaining its residence. The State is the primary manager of natural resources that is the most dependent on the resources of the Bering Sea, so we envision a productive and ecologically diverse Bering Sea that will provide long-term sustained benefit to local communities and the nation, which is the vision of the Bering Sea that has guided the development of the draft science plan and effectively captures the State's perspective.

The importance of marine ecosystems to the State is embodied by the proclamation of 1998 as the Year of the Oceans by the U.N. and reiterated by the Governor. I am concerned, as with all of us, about the changes occurring in the Bering Sea, the decline of Steller sea lions, certain bird species and slow recovery of some fish species that have been depleted by fisheries exploitation. The health of the Bering Sea is vital to sustainable use of natural resources and the efficacy of management policy. Understanding these dynamics and how global and decadal scale climate changes interact with human impacts to shape the ecosystem is a daunting task. Attainment of this understanding will require the incorporation of traditional knowledge and coordinated research efforts of the community of agencies and academic institutions with common interest in the Bering Sea. Key elements in the implementation of these research objectives are sustained support, coordination, communication, and involvement of local communities as stakeholders.

I would like to thank the agency staffs for their excellent and effective cooperative effort to develop the Draft Bering Sea Ecosystem Research Plan that you have before you. The plan has synthesized an immense amount of a material into a coherent and effective roadmap for coordinated research. However, the plan has had little input from entities outside the agencies. The involvement of universities and private research organization in the planning, actual data collection and the research is essential to development and implementation of the Bering Sea ecosystem research initiative. This workshop is an important first step in developing a broad consensus on fishery and ecosystem management issues and research and approaches. I am really excited about having a broader community of scientists take a look at this plan and make sure that we have captured all the issues.

Overview of the draft research plan

PAT LIVINGSTON, NATIONAL MARINE FISHERIES SERVICE, ALASKA FISHERIES SCIENCE CENTER

The draft plan that we have are presenting here today came from one of the recommendations of the last workshop in December. The recommendation was to develop an integrated research plan for the Bering Sea so that we wouldn't have these "Groundhog Days" over and over again creating a different science plan every time. What the interagency group of scientists did in the last few months was to take all the various planning efforts that had been done for the Bering Sea and to make an integrated plan from all those.

This morning we will hear from Clarence Pautzke, who will speak about some of the most important issues in fishery management. We also want to hear from all of you. Because right now what is in the plan is a scientist's view of what they think the most important management issues are. What we really want to have here is science that is meeting the needs of management and not science for science sake. So we want to make sure that what gets done are the things that are most important, that are going to help us in our fishery and ecosystem management in the Bering Sea. So please speak up and let us know what you think is important.

This afternoon we will have some of the leaders of the Native community tell us about the next steps for incorporating traditional knowledge into the research plan. At the last workshop we heard about traditional knowledge. We've heard many things about what it is. Because traditional knowledge belongs to the Native community and they are the ones that need to direct how it is used, we want to hear how traditional knowledge will fit into this science plan, what do they think are the next steps. Because traditional knowledge is really a way of approaching all the science issues that we have, a way of knowing about the questions we have about the Bering Sea, we thought it was appropriate to have it before we went into the breakout groups to hear how it would fit into all of the pieces of research.

We have breakout groups for climate variability and ocean processes, individual species responses to perturbation, food web dynamics, contaminants and habitat. In those groups we will have our leaders present what is presently in the theme and some of the questions that we hope to address in the themes. What we want to hear is what are the most important, unfunded or under-funded research projects that we need to do to address these various themes and what are their priorities. There is a section in the plan right now that is called "present research needs" that attempts to do that. We derived some of the information there from what we got from the last workshop where we had scientists identify what the data gaps and research priorities were. But we want to hear from a broader audience what you think about that. That will occur in the breakout groups.

I want to talk briefly now about some of the pieces that we probably will not get a chance to talk about in the breakout groups. If you have comments on any of these parts, please try to get them to us, either right here at the workshop in writing or very soon, so that we can add and modify the plan appropriately. I want to talk about the vision of the Bering Sea, the overarching hypotheses and, about some implementation aspects. In our vision statement for the Bering Sea, we made a succinct statement about what we saw for the future of the Bering Sea. In this statement we said: "We envision a productive, ecologically diverse Bering Sea ecosystem that will provide long-term sustained benefits to local communities and the nation." So we want to especially think about long-term sustainability, that we want something that is important not just for the nation, some nebulous group of people, but something that's important to the people that live around the Bering Sea. When we say productive, we don't just mean fisheries production, we're talking about consumptive and non-consumptive uses of the Bering Sea. Also, in this science plan we need to have some overarching or some hypotheses that we want to address. After synthesizing all the various planning efforts that have been done in the past, we came up with these two statements. One, that is really a hypothesis about climate effects on the system and one that is a human impacts hypothesis. We welcome your comments on those.

Although we did not create an implementation plan, we thought it was important to outline what we thought were some of the key aspects of implementing this research. Those were that there would be, first of all, sustained research support. We don't want to be thinking from year to year, are we going to have money? How can we have a long-term vision of research and research that feeds into management for the Bering Sea without some way of sustaining research support for the plan. As we heard this morning from all of our leaders, this coordination and communication with each other are very important aspects of implementing the research. Communicating with each other, developing partnerships with each other and involving local communities and stakeholders in all of these aspects are important in implementing this plan.

Forum: Important issues for the Bering Sea

CLARENCE PAUTZKE, EXECUTIVE DIRECTOR, NORTH PACIFIC FISHERIES MANAGEMENT COUNCIL

Clarence began this session by listing the issues mentioned in the plan and providing a fisheries management context and perspective on the importance of those issues. The main issues he discussed were:

- FISHING EFFECTS ON STELLER SEA LIONS
- FISHING EFFECTS ON SEABIRDS
- LOCALIZED DEPLETION OF PREY IN FORAGING AREAS
- FISHING EFFECTS ON BOTTOM FAUNA AND STRUCTURES -- HABITAT DEGRADATION
- EFFECTS OF WASTE AND DISCARDS
- EFFECTS ON FISH POPULATIONS
- PROTECTION OF BIODIVERSITY
- CONTAMINANTS, PLASTICS, OTHER MATERIALS
- EFFECTS ON SUBSISTENCE RESOURCES
- EFFECTS OF LARGE SCALE SALMON ENHANCEMENTS
- COASTAL DEVELOPMENT IN NURSERY AREAS
- INTRODUCTION OF EXOTIC SPECIES VIA BALLAST WATER
- LONG-TERM CHANGES IN THE CLIMATE AND OCEAN CONDITIONS, OCEAN WARMING

Prioritization of those issues from a fishery management perspective is seen in the figure below. At the forefront of the issues facing the North Pacific Fishery Management Council are those involving Steller sea lions. Other marine mammal and bird issues, particularly the effects of localized depletion of bird and mammal prey were seen as high priority. Although contaminants has not yet been in the forefront as a critical issue, there is a great importance to ensuring the health and safety of humans, so research effort needs to be expended to make sure that it does not become a problem. These are the main issues that require immediate attention.

Other issues that are important and could benefit from a long-term research program are those involving the effects of trawling,biodiversity, marine reserves, fishery wastes and discards, pollock, and the study of regime shifts. It wasn't clear whether some issues such as introduction of exotic species and coastal development were important in the Bering Sea region. A particular emphasis was placed on the need to provide support to the Russians to study the western Bering Sea, given the present expansion of Russian fishing fleets and the lack of Russian resources to do research.

Audience discussion followed the presentation. Many issues were raised about the priorities presented. One issue had to do with the total dollar amount available, which is possibly only half of the money that was spent during the Outer Continental Shelf Environmental Assessment Program (OCSEAP), and how to allocate the research dollars to critical management issues versus longer-term research needs given that limited research budget. A point was made that we can't put all our money into the critical management issues because these short-term concerns are the result of a long-term lack of accumulated knowledge. A long-term research program needs to be instituted that is directly tied into gathering types of information that can also address the short-term management concerns. Broad-scale monitoring of the whole system is probably not feasible given the research budget. A more focused approach, using indicator species and sites was recommended for development. Using the fishing fleet to gather ecological information and performing adaptive management experiments were also mentioned as ways of learning about the system.

Another important issue was raised on the need to do research to understand the effects of climate on the ecosystem. It is apparent that fluctuations in many managed species are not the result of the management regime, but are climate-induced fluctuations. Managers could benefit in the long-term from a program that could provide forecasts on what will happen with phytoplankton production, the coupling of phytoplankton to zooplankton, with forage fish, and therefore available food for managed species. Doing the process studies and other research that will assist us in building models will provide that predictive capability.

Traditional Knowledge

PATRICIA COCHRAN, EXECUTIVE DIRECTOR, ALASKA NATIVE SCIENCE COMMISSION
HENRY HUNTINGTON, PRIVATE CONSULTANT
LARRY MERCULIEFF, BERING SEA COALITION

Indigenous peoples throughout the world have sustained their unique worldviews and associated knowledge systems for millennia, even while undergoing major social upheavals as a result of transformative forces beyond their control. Many of the core values, beliefs and practices associated with those worldviews have survived and are beginning to be recognized as having an adaptive integrity that is as valid for today's generation as it was for generations past. The depth of indigenous knowledge rooted in the long inhabitation of a particular place offers lessons that can benefit everyone, from educator to scientist, as we search for a more satisfying and sustainable way to live on this planet (Kawagley & Barnhardt, 1997).

Traditional knowledge is a way of knowing that encompasses all the research themes in the Bering Sea Ecosystem Research Plan. A panel with expertise in traditional knowledge was convened to provide a perspective on what the next steps should be for making progress in this area. Invited speakers, Larry Merculieff, Patricia Cochran, and Henry Huntington expressed frustration at the endless forums talking about traditional knowledge that produce no results.

Historically, people from the Pribilof Islands expressed their concerns about unusual animal patterns and behaviors to groups with the Senate Foreign Relations Committee on renewal of the Fur Seal Treaty, when they suggested legislative language to mandate an ecosystem approach. Rigorous attempts to link local people with Western science programs began in the early 1970's with the North Pacific Management Council. Although the Bering Sea Ecosystem Conference proposed that Native peoples serve as equal partners in multi-disciplinary projects, western science is not structured to incorporate, assess or validate traditional knowledge. Science does not know how to respond to Native traditional ways of knowing. Therefore, despite the continuous efforts of Native people to bring attention to their insights and the value of traditional knowledge, Western scientists could not relate to their way of knowing the world in which they live.

A summit of tribes and communities which encompass all regions of the Bering Sea ecosystem is called for because all affected communities must be represented and have the opportunity to speak individually and collectively about issues that affect them. These communities from Alaska and Russia need support to meet on a regular basis to coordinate, cooperate, collaborate, conduct demonstration projects or whatever else the communities deem necessary. The communities need to be the ultimate decision-makers using culturally appropriate systems and processes. Alaska Native organizations took two years to reach consensus on the approach to co-management for the Marine Mammal Protection Act. This decision-making process works effectively and can give concrete results.

A "Council of Elders" is proposed to function as traditional leaders and guides in Native knowledge for the people of the Bering Sea region. Native hunters, gatherers and fishers who have had contact with science will likely lead as social bridge-makers.

The communities must be given a decisive role in how projects are done and which of the results are communicated. Since the information is theirs, they have a right to do with it as they choose.

For example, in research on beluga whales, information on fishing in Norton Bay was left out of the published report because commercial fishermen did not want others to know their trade secrets, jeopardizing their livelihoods.

Evaluators for funding projects must be able to relate to traditional knowledge and Native community values. It is important to know the people who can evaluate proposals on Native science as well as western scientific merits so that traditional knowledge proposals are funded. Commonly the only justification to support traditional knowledge was because it could give considerable insight into other research and activities going on in the Bering Sea. Such a narrow view cuts off a tremendous resource. Funding for the North Pacific Research Board should include funds for projects designed and operated as partnerships with Native communities, which promote community initiated research and employment and training opportunities.

Taking time to work with communities is vital. Natives have learned to use entire ecosystems to validate conservation practices. For example, several tribal chiefs were listening to officials with Fish and Game talk about aerial moose surveys and moose transects. The officials were thinking about introducing a cut in subsistence take of moose. The chiefs asked the officials if they had noticed the water levels going down and the beavers building more dams in the area. No, they answered, because they had been doing aerial surveys. When asked if they knew that when the water levels go down, the forage that the moose depend on die, the officials suggested they tell that to the Board of Game. A silent groan was heard among the chiefs because the Board of Game validates western science, not traditional knowledge. And so, in disenfranchising a whole group of people and their ways of knowing, important information about the environment is invalidated. Because of this invalidation by project leaders, thousands of years of knowledge is lost by not hearing the wisdom of the elders and the history they bring. More importantly, the denigration of tradition and traditional knowledge tears the fabric of the Native culture, making it that much harder to pass on old wisdom to young souls. This is what is happening in the Bering Sea region.

An important step for western science is to validate reports based on traditional knowledge whether the report accurately represents and portrays what the community has to say without interpretation and adornment. Validation of traditional knowledge has the social impact of empowerment and respect. It gives credibility to traditional knowledge within communities. People will get involved when they know their knowledge is respected, and they should be involved from the beginning. Traditional knowledge cannot always be validated using the western scientific method.

At the Sustainable Development Conference in Whitehorse many Native groups, Canadian, Russian, Indian and Alaskan indigenous people, agreed that wisdom is an integral part of traditional knowledge. They agreed that the term "traditional knowledge" was the most common and understood terminology throughout indigenous communities and was the preferred term. The Native worldview considers knowledge to be circular and interconnected and to separate one specific element, as in traditional ecological knowledge, does a disservice to what traditional knowledge encompasses.

Traditional knowledge should not be compartmentalized or checked off a list of proposals. Partnerships are important but preferably not mandated or required through legislation. Funding agencies should look at community support and participation and ethical standards for conduct of research.

Incorporating Native traditional knowledge was compared with incorporating the feminine. If, in every forum, in every institution, Native knowledge and wisdom is incorporated, then it becomes different than a partnership. It becomes absorbed into the whole, dissolved over time through all cultural systems.

It is important to connect all the communities in the Bering Sea area to share information. Environmental indicators could be picked up before anyone else knows what is going on, because local communities, who are the first observers, could identify anomalous behaviors over wide geographic areas. If the communities wished to be involved in western science, such as monitoring and tissue sampling (as many already are), they could use the internet, and a Bering Sea Bulletin Board could be set up to share knowledge. If that kind of system were adopted, everyone would have real time observations, which could be put into a central clearinghouse. Perhaps a portion of the bulletin board could be encrypted just for local access. Using such a system would allow all schools to be tied into common science and research projects that perhaps could be designed using traditional knowledge and western science.

It is important for elders to participate in the school setting for children to learn both western science and traditional skills. Young people are reluctant to appreciate traditional knowledge and have not learned from elders in the traditional way. Likewise, it is important to operate within the traditional context to be able to use traditional knowledge. When information is gathered in non-traditional ways, the system that traditional knowledge is based upon gets lost.

The drastic changes in species' populations will compel cooperation between all parties. Meanwhile, at least six higher trophic species are in a state of severe and sustained decline. Seabird declines are a red flag. Viability of our coastal communities is being threatened, culturally, economically and spiritually.

The people speaking most passionately about these problems are people from the affected communities. On St. Paul Island, the Native people say that the fur seals will go through a third series of precipitous declines in the next four years. Each time the Native peoples have given a similar warning, they were ignored and later said, "We told you so." Hopefully these warnings will be heeded before it is too late to reverse the population declines. Now is the time, for a commitment from the government to preserve these values and the environment in the Bering Sea. More and more people are aware of the important environmental issues in the Bering Sea. In summary, the next step is to get the support and commitment necessary to pull together the vision we all share.

<u>References</u>

Kawagley & Barnhardt. 1997. Education Indigenous to Place: Western Science Meets Native Reality. Ecological Education in Action, March 1997.

Discussion Group Reports

CLIMATE VARIABILITY AND OCEAN PROCESSES

Co-chairs: Jim Schumacher and Jeff Napp

One item that our group felt should be addressed was that much of the necessary research needs to encompass the entire Bering Sea, not just the eastern Bering Sea. It is logical that coordination with Russia would take some time, so that basin wide studies may be a few years in the future. Also, the physical studies need to be closely matched to biological studies. For example, if the highest priority is Steller sea lions, then the necessary physical studies might be on a far different spatial scale than if broader ecosystem questions are the highest priority. That is, the biology should drive the physics. This would help to establish priorities.

We felt that the Overarching hypothesis needed some change and came up with:

1. Natural variability in the physical environment causes shifts in trophic structure and changes in the overall productivity of the Bering Sea.

We also felt that the two themes [Climate variability and Ocean processes] could be combined into one: Processes and variability in the physical environment. The former 14 questions were compressed into 6 basic questions:

1. What are the mechanisms and relevant time scales of climate induced variability of the physical environment which most influences biological component of the ecosystem? For example, are physical environmental regime shifts the dominant factor driving major changes in the biology of the ecosystem?
2. Can we separate anthropogenic effects from natural variability?
3. What would be the effect of global climate warming on the physical environment and how would the predicted change affect the present species mix and productivity of the Bering Sea?
4. How does climate variability affect physical oceanographic processes (e.g., current, fronts, eddies, stratification, etc.) and, in turn, how do these processes affect biological productivity, trophic structure and yield of living marine resources?
5. How does climate variability influence seasonal production and extent of sea ice and what is the impact of such variation on primary production and the food web?
6. How does variability in micro/macro-nutrient availability affect productivity of the Bering Sea?

The group then defined the following set of studies and assessment of their priority.

Monitoring Studies:
Objective is to collect physical, chemical and biological observations at pulse-points in the ecosystem. [feasibility (High, Medium), duration (Long Term or Medium, about 5 yr., or Short Term of 1-2 yr.) and priority (High or Medium) are indicated in brackets.

1. Maintain and enhance time-series (both moored biophysical platforms and discrete samples) at Bering Strait, across the southeastern shelf (PROBES and Southeast Bering Sea Carrying Capacity Lines), Aleutian North Slope Current, Unimak Pass, etc. Incorporate/develop continuous biological sensors to complement continuous physical sampling systems. Place observations on the World Wide Web in real-time. [H, LT, H]
2. Develop facilities and train local people to collect physical, chemical and biological observations from islands (St. Paul, St. Lawrence, etc.) and coastal villages. Include local interpretation of these observations in publically-accessible data summaries. [H, LT, H]
3. Initiate monitoring of the inflow of Alaskan Stream water and its chemical and biological constituents through selected passes of the Aleutian Island chain (Amukta, Amchitka, etc.). [H, LT, H]
4. Initiate and/or enhance ship of opportunity data collection. Provide long-term support for data analysis and dissemination. Examine the potential use of satellite collars on marine mammals. [H, LT, M]
5. Archive in geographical registered format and provide preliminary interpretation of all available satellite remote sensing (ice, sea surface temperature, ocean color, synthetic aperture radar, etc.) in near-real time. [H, LT, M]
6. Maintain or reinstate monitoring of river discharge (particularly the Yukon River). [H, LT, M]

Retrospective Studies:
Objective is to analyze existing observations to elucidate ecosystem (both physical and biological components) status and change.

1. Establish base-line conditions (including inherent variability), e.g., mixed layer depth, water column temperature and salinity, cold pool extent and heat content, etc., throughout the study area. [H, M, H]
2. Establish linkages among atmosphere-ocean-sea ice system, primary production and biological energy flow. Form conceptual models from these linkages. [H, M, H]
3. Characterize the time and space scale of climate forcing. [H, M, M]

Modeling Studies:
Objective is to use models as tools to examine how the ecosystem functions and to aide retrospective studies by providing indices of the physical environment.

1. Development/implementation of a primitive equation model of the entire Bering Sea. [H, LT, H]
2. Incorporate submodels for: (a) nutrient-phytoplankton-zooplankton, (b) individual based models for nodal or commercially valuable species, and (c) ice dynamics. (a) [H, ST, H], (b) [H, ST, H], and (c) [M, ST, H]
3. Provide indices of transport, current patterns, eddy-fields, etc. from (1). [H, LT, M]

4. Examine how does climate change alters flow through the Aleutian Passes and hence circulation in the Bering Sea using (1). [M, ST, M]
5. Develop models to examine single processes, e.g., sediment resuspension (in relation to effects of bottom trawls), mixed layer stability and plankton blooms, etc. [H, ST, M]

<u>Process oriented Studies</u>:
Objective to examine processes critical to the linkage between physical and biological processes. These typically are field and laboratory studies which could be augmented by model exercises.

1. Examine the mechanisms that determine nutrient replenishment on the continental shelves. What determines the cross-shelf flux of nutrients (both micro and macro nutrients) and what are the time-space scales of such fluxes. [M, M, H]
2. Determine the mechanism and processes that control survival of early life history stages of commercially valuable species, marine mammals and sea bird fledglings. [M, LT, H] Determine the strength of the relationship between survival during early life history stages and eventual recruitment.
3. Determine how sea ice, sea surface temperature and the extent of the cold pool affect the transfer efficiency of primary production to the pelagic and benthic food webs. What is the magnitude of the influence. [M, LT, H]
4. Determine the role of summer storms and their attendant mixing on annual production and trophic efficiency of the Bering Sea shelf. [H, M, H]

INDIVIDUAL SPECIES RESPONSES TO PERTURBATIONS

Co-chairs: Gordon H. Kruse and Vernon Byrd

Scientific Background

Perturbations:
Gordon Kruse opened the breakout group session by outlining some of the commonly observed major changes in individual species: (1) distribution, (2) growth, (3) survival, and (4) recruitment (fishes) or productivity (birds and mammals). Typically, recruitment variations dominate fish and invertebrate population dynamics. Environmental factors often thought to have great influence on the early life stages of fish and invertebrate species through the starvation, advection and predation mechanisms.

Important biological processes may be mediated by physiology: (1) maturity, (2) spawning/mating timing, (3) incubation period, (4) hatch timing, (5) hatching success, (6) hatch size, (7) morphology, (8) swimming speed, and so on. Species changes at these levels can be manifested in changes in growth, survival, and recruitment/production.

Physical factors that most commonly influence physiology are temperature, oxygen, salinity, and light. However, there are other important environmental and ecological factors that can affect a species success: (1) atmospheric pressure systems, (2) ocean currents, (3) wind mixing, (4) stratification, (5) location of ocean fronts, (6) solar radiation, (7) sea ice, (8) status of parental population, and (9) abundance and distribution of prey, predators, and competitors.

Anthropogenic factors can have significant effects on individual species, as well, including: (1) harvest, (2) bycatch, (3) effects on population size/age structure, (4) genetic selection for individuals with particular attributes, (5) habitat alteration, (6) enhancement, and (7) species introductions, among others.

Population Changes in Some Commercially-Important Fish and Invertebrates
Gordon Kruse gave an overview of some of the major observed changes in commercially-important fish and invertebrate species in the Bering Sea and Aleutian Islands. Assessments of groundfish populations are conducted annually by NMFS using age-structured models of survey and fishery data. Crab stock assessments are based on trawl surveys by NMFS and length-based models by ADF&G. Results are reported in annual stock assessment and fishery evaluation reports available from the North Pacific Fishery Management Council.

Walleye pollock comprise the most valuable fishery. Big changes occurred in the Donut Hole (outside the exclusive economic zones of the U.S. and Russia) where large international fisheries developed in the early 1980s, overfishing occurred in the late 1980s, and the fishery collapsed in the early 1990s. Now an international agreement is in place to prevent future overfishing. By contrast, the domestic fishery in the eastern Bering Sea has been managed conservatively, although variations in recruitment have led to significant population changes including a large increase from the late 1970s to the mid-1980s, a decline to intermediate stock size in 1991 followed by an increase to a second peak in 1993, and followed by a steady decline to intermediate stock sizes in recent years.

Trends in Pacific cod are rather similar to pollock. Sablefish had a similar population increase from the late 1970s to the mid-1980s, but a steady decline since then (unlike pollock and cod). Many species of flatfish (e.g., yellowfin sole, rock sole, arrowtooth flounder) increased dramatically in the late 1970s through mid-1980s and have remained high since then. A striking exception to this flatfish pattern is Greenland turbot, which increased from the mid-1960s to early 1970s, and has declined ever since. Pacific Ocean perch declined from the early 1960s to late 1970s due to overfishing by foreign fleets, increased until the late 1980s in response to conservative management subsequent to extension of U.S. jurisdiction to 200 miles offshore, and leveled off at a low to moderate level of abundance in the 1990s.

Bering Sea herring are largely comprised of the population that spawns near Togiak. In response to two very large year classes in the late 1970s, the population increased from the late 1970s to mid-1980s, and it has since steadily declined to intermediate levels. On the other hand, the smaller stock of Norton Sound herring steadily increased from the early 1980s to the early 1990s, and has since leveled off.

Overall, eastern Bering Sea salmon production (landings) cycled over time. Most of the changes are attributable to well-known dominant/weak cycles of returning sockeye salmon. A sharp increase in production was reported in association with a regime shift in the late 1970s. However, this increase in production may have been exaggerated since sockeye fisheries in the Egegik, Ugashik, and northern Alaska Peninsula areas were not fully developed until the 1980s. Management and environmental changes are likely to have combined to cause decadal shifts in return per spawner indices of production.

Abundance of red king crabs in Bristol Bay increased steadily through the 1970s followed by a steep decline in the early 1980s associated with recruitment failure, increased natural mortality, and high harvest rates. The stock increased somewhat since the early 1980s, although a strong 1990 year class is expected to result in a temporary increase in abundance. Blue king crabs at St. Matthew and Pribilof Islands declined in the 1980s, and increased into the 1990s. Tanner crabs declined steadily from a peak in the mid-1970s to the mid-1980s, increased in the late 1980s to early 1990s, and declined precipitously in the mid- to late 1990s to record low levels of current abundance. On the other hand, snow crabs increased from the mid-1980s to the early 1990s, declined sharply to the mid-1990s, and increased sharply in the late 1990s; a second sharp decline is expected to begin around 2000. Wide swings in crab abundance are largely attributable to occasional years of very strong recruitment followed by many years of weak recruitment.

Population Changes in Birds and Mammals

Vernon Byrd presented an overview of changes in some mammal and bird species in the Bering Sea and Aleutian Islands. Steller sea lions experienced declines over much of the range since about 1965. The species is listed as endangered in the western portion of its range and threatened in the eastern portion of its range. Causes of declines remain uncertain, though most hypotheses involve prey availability.

Fur seals declined in the 1970s, but have been stable since about 1982. At St. George Island there is no indication of a decline in harem or idle adult males. Fur seal pups declined in the 1970s to early 1980s, but they have remained stable since then.

The depletion of sea otters by early fur traders is well known. Since the termination of hunting, populations have increased in numbers and expanded in distribution throughout their former range. At Adak Island, and elsewhere in the Aleutian Islands, sea otters increased during the period 1950 to 1980, but they have declined since about 1982 despite an apparently healthy population of sea urchins as prey. There is speculation that predation by killer whales is partly responsible for the recent decline.

Patterns of change for marine birds have varied among species, locations, and decades in the Bering Sea over the past 20-30 years. For example, spectacled eiders on the Yukon Delta have declined since 1972, and several other species of sea ducks also seem to be declining. Population trends of several species of colonial nesting seabirds were reviewed. Storm-petrels, surface-feeding planktivores, have increased since the late 1980s at several monitoring sites in the Aleutians, whereas some of the fish-eating species have declined since the mid-1970s in the eastern Bering Sea. For example, murres, diving piscivores, declined in Norton Sound between the mid-1970s and early 1980s, and declined in the Pribilof Islands between 1976 and the early 1980s. In contrast, murres increased from the mid-1970s to the mid-1980s in the western Aleutians. At other sites, like Cape Peirce in Bristol Bay, no obvious trends in murre numbers have been detected during this same period. One high profile example of population decline is that of the red-legged kittiwake, a Bering Sea endemic, in the Pribilof Islands between the mid-1970s and mid-1980s. The population has remained relatively stable thereafter at mid-1980s levels. Since 80% of the world's population of red-legged kittiwakes occurs at one breeding site, St. George Island, these declines are particularly noteworthy. Nevertheless, red-legged kittiwake populations have increased over the same period at Buldir Island in the western Aleutians.

Vernon Byrd pointed out the need to consider that not all sources of change have marine origins; some perturbations are the result of terrestrial processes. For instance, Aleutian Canada geese and a number of other endemic taxa declined as the result of predation by foxes that were introduced to the Aleutian Islands. The goose population and other species increased after removal of foxes. Also, accidental introductions of rats is a problem that needs additional conservation efforts.

Breakout Group Discussions

Preliminary Discussion:

The breakout group had many good discussions about the topic of "Individual Species Responses to Perturbations." We recognized that there were significant overlaps with other groups. In particular, our topic was closely connected to "Food Web Dynamics" and "Climate Variability and Ocean Processes." Changes in processes in both of these realms lead to perturbations in individual species. Nevertheless, our breakout group tried to reduce overlap to the extent possible.

Our approach was to review the questions in the draft science plan, attempt to modify them by making them more general, and then to provide high priority categories of research approaches, with examples that bear on those questions. We were tasked with providing examples under the categories: retrospective, monitoring, modeling, and process studies. We added a fifth category of "experimental studies" that were not necessarily process-oriented. The examples that we provided under each research category were merely examples, nothing more. Many more examples with other species could have been provided. Thus, the examples do not indicate preferences by the breakout group. Finally, the proposed categories of research approaches were all considered high priority, but the list is not exhaustive.

Questions:

The draft Bering Sea Ecosystem Science Plan dated April 24, 1998 provided examples of specific research questions that could be investigated under the topic of "Individual Species Responses to Perturbation." The group reviewed these questions, and developed the following three parallel, general questions that fit under the two overarching anthropogenic and physical hypotheses in the plan.

Anthropogenic

1. What are the current and projected changes in human uses (e.g., fisheries) in the Bering Sea?
2. How do different populations of indicator species or species groups respond to anthropogenic perturbation?
3. How should natural resource management systems respond to anthropogenic-induced population change?

Environmental

1. What are the patterns of spatial and temporal change in the atmosphere, ocean, and land components of the Bering Sea?
2. How do different populations of species and species groups respond to physical and biological changes in the Bering Sea?
3. How should natural resource management systems respond to physical and biological change?

Research approaches:

All of the following categories of research approaches (retrospective, monitoring, modeling, and process studies) were suggested as high priorities. For some research categories, examples (not prioritized and not exhaustive) were volunteered by the group. In addition, each example was evaluated with respect to feasibility – relatively easy (E), moderately difficult (M), and difficult (D) and with respect to study duration – 1-3 years (1-3), 3-5 years (3-5), and longer (>5).

Retrospective

1. Evaluate ongoing monitoring efforts for efficiency and effectiveness [E, 1-3].
2. Construct or obtain databases from available information (including traditional knowledge) on indicator species (e.g., walrus harvest data from eastern and western Bering Sea) [M, 3-5].
3. Evaluate the relative impacts of anthropogenic versus physical (and biological) factors on patterns of change with appropriate long-term databases (e.g., sockeye salmon, fur seals) [M, 1-3].

Monitoring

1. Build on existing monitoring programs by establishing partnerships to leverage resources (e.g., groundfish data from crab surveys) [E, >5].
2. Establish new monitoring programs for indicator species not currently covered (e.g., sea ducks, copepods) [E, >5].

Modeling

1. Conduct statistical and modeling studies on physical (and biological) factors to investigate changes in productivity [E - depending on the study, 1-3].
2. Model effects of physical and biological factors to analyze alternative natural resource management strategies [E – depending on the study, 1-3].
3. Develop models to forecast responses to perturbations and appropriate mitigation with a feedback loop to experimental studies (e.g., marine mammal behavioral responses to human perturbations) [M, 1-3].

Process Studies

1. Evaluate experimental management strategies (e.g., effects of closure zones on marine mammal populations) [D, >5].
2. Evaluate causes of changes in trophic interactions (e.g., predator-prey relationships between marine mammals, cannibalism in fish) [D, >5].
3. Evaluate the effects of oceanographic features on selected species (e.g., concentrations of fish at fronts, walrus at ice edge) [M,3-5].
4. Determine effects of coastal development on subsistence activities [M, 1-3].

Experimental Studies

1. Conduct field studies of effects of various human activities or changes in physics on animal populations (e.g., physiological effects of nutritional stress on sea lions, trawling effects on fish school structure or benthic communities) [Variable difficulty, study duration depends on particular study].

FOOD WEB DYNAMICS

Co-chairs: Pat Livingston and Peter McRoy

Attendees: Peter McRoy, Pat Livingston (co-leads), Bruce Wright, Kathy Rowell, Nina Young, Ron Dearborn, John Schoen, Margaret Williams, Patricia Cochran, Art Kendall, Don Schell, Don Callaway, Walter Parker, Vivian Mendenhall, David Irons, Joe Sullivan, Jeff Napp, Gary Sonnevil, Dana Seagars.

The breakout session began with an overview of the processes and questions presently contained in the food web dynamics theme. In order to make the plan as complete as possible, we developed and discussed questions and approaches that were not in the theme. Very little time was spent amending or discussing research that was already in the plan so that we could focus on making sure the full-range of scientific concerns were represented.

Additional questions identified by the group:

1. How does variability in ocean structure (e.g., stratification, upwelling, cold pool, ice edge) affect prey availability to upper trophic level species?
2. How can we separate human and climate induced effects on the food web?
3. How does fishing influence food webs?
4. How can adaptive management be used to better understand the influence of fishing on food webs?
5. How does temperature variability affect the transfer efficiency of energy through the food web?
6. How do contaminants including fish processing offal and pollutants from sunken boats affect food webs?
7. What level of information do we need to have to influence the decision process?
8. How can local and traditional knowledge become part of addressing these questions?
9. What level of models are appropriate?
10. What are the major determinants linking the physical/chemical variables and seasonal primary productivity in the Bering Sea? What proxy can be used (and validated) to monitor relative primary production in the Bering Sea?
11. What controls successful recruitment of euphausiids and large pelagic copepods? What controls their fates?
12. Are there other critical zooplankton species/populations supporting fish?
13. What competitors (fish, jellyfish, seabirds) vie for zooplankton resources?
14. Do threshold prey densities exist for top consumers?
15. Do consumers have dietary flexibility?
16. What controls the production of prey for the early life history stages of fish, marine mammals and seabirds?
17. Is survivorship or mortality of these early life history stages affected by the length of the food chain between primary production and upper trophic levels (i.e., diatom-copepod/euphausiid-apex predators versus nannoplankton-microzooplankton-macrozooplankton-apex predators)?

Suggestions for additions to research approaches

Modeling

1. Develop spatial models of predator foraging and energetic models of prey demand.

Model the effects of a western Bering Sea oil spill on Bering Sea food webs.

Monitoring

1. Systematic harvest monitoring of species linked with observations of long-term trends from hunters.
2. Continue the multidisciplinary monitoring transects off the Pribilof Islands.
3. Employ biophysical monitoring buoys and remote sensing.
4. Monitor status and trends of marine mammals and birds, including presently unmonitored groups such as ice seals and crevice-nesting birds.
5. Monitor food web dynamics of key seabirds and marine mammal species at keys sites in the northern Bering Sea.
6. Monitor nearshore forage fish.
7. Monitor phytoplankton and secondary production linkages.
8. Development of instruments to measure abundance of less abundant organisms from buoys.

Retrospective analysis

1. Survey archaeological middens and sediment cores to look at species abundance and changes.
2. Analyze ice cover and other environmental factors on predator/prey population dynamics in the northern Bering Sea.
3. Analyze seabird colonies (Pribilof Islands and Buldir Is.) and productivity relative to forage.

Process

1. Continue SMMOCI (Seabird, Marine Mammal, and Oceanography Coordinated Investigations) and link it to basin-wide monitoring of forage.
2. Conduct studies to understand the effects of fishing on marine mammal and seabird food webs.
3. Perform experiments, including adaptive management experiments, involving marine refugia.
4. Elucidate the role of predation in affecting population trends of seabirds and marine mammals.
5. Study different phytoplankton communities and transfer efficiencies of phytoplankton to zooplankton.
6. Link resulting prey production to recruitment success of upper trophic level species at critical times in their life history.
7. Study climate controls of nutrient supply, production, and energy transfer to upper trophic levels.
8. Apply APEX predator studies performed in Prince William Sound to the Bering Sea.

Implementation Issues
Several general areas were identified that could be further emphasized or added to the research plan. These areas were not necessarily specific to the food web dynamics theme. Many of these areas should be considered specifically in implementing the research plan and guiding research funding priorities:

1) questions which could be answered using an adaptive management approach
2) preference given to research on keystone and proxy species for monitoring
3) the need to develop a process to obtain input from scientists, fishermen, Alaskan Natives, and conservationists in all aspects of the research effort
4) the need to place more emphasis on possibilities for U.S.-Russian cooperative work
5) goals for setting research priorities

Members of the group decided not to prioritize the research approaches discussed during the breakout group session. Instead, we developed a list of aspects to consider when deciding on research priorities:

1) Multidisciplinary projects.
2) Relevance of the project to the overall goal.
3) Relevance of the project to other elements of the science plan.
4) Ability of the project to contribute to long-term prediction.
5) Ability to contribute to critical near-term management concerns.
6) Coordination of the project with existing research on similar topics.
7) Project emphasis on a keystone or proxy species approach.
8) Project inclusion of local and native communities or U.S./Russian cooperation.

CONTAMINANTS AND OTHER INTRODUCTIONS

Chair: Philip Johnson

The Contaminants breakout group began with a general presentation on the recommendations of the draft Bering Sea Science Plan so that all participants were familiar with the issues and proposed approach. The three main topics under consideration were, 1). Contaminants issues, 2). Exotic/introduced species, and 3). Trash, debris and discarded fishing gear.

The group noted that while many key issues were raised in the Science Plan, specifics were lacking. There is a need for a detailed, stepped-down plan with line items (i.e., projects) including costs. There is no discussion which identifies the key species to monitor, what contaminants need to be analyzed, nor is there discussion of what biological effects are of interest (such as population trends, animal health, reproductive success, etc.). This level of detail needs to be added to the Plan. Another item missing from the original science plan was a discussion of oil spills and their effects on Bering Sea resources and related spill response contingency planning efforts.

Contaminants Issues

There was consensus that we need to establish a contaminants baseline for the Bering Sea ecosystem, and monitor through time to determine if levels of various pollutants are declining, increasing or remaining stable. Abiotic samples and tissues from key species representing different trophic levels or feeding guilds should be collected and analyzed for contaminants. Questions about contaminant transport, fate and effects cannot be answered without these data. Most contaminants studies to date have been relatively short-term and species- or issue-specific. Funding for a structured long-term contaminants monitoring program has been lacking. It was recognized that we cannot collect baseline data for all species, all potential contaminants, and at all locations with limited funds. Thus an approach focused on key species from trend sites located in coastal communities was proposed, supplemented by "platforms of opportunity" (vessels) for offshore work. There is also a need for special studies to address specific problems that might not be covered under a core monitoring program (e.g., in-depth monitoring of localized contaminants "hot spots", experimental studies, or directed fate-effects assessments). Near-shore work will probably be more affordable due to the relatively high cost of operating vessels in the Bering Sea.

The group did not feel it was appropriate for us to recommend specific contaminants studies at this juncture since time was limited and some key participants in the contaminants area were not able to attend the workshop. There was general agreement that a literature search and investigation into existing information (including summarization of existing research projects and studies from the "grey literature") was a critical first step to avoid duplication of efforts and to help clearly delineate data gaps.

The workgroup developed and refined the structure for a matrix which might be used to lay out the needed information (Table 1). The matrix would be organized by the type of habitat (Terrestrial and Freshwater, Near-Shore Marine, Offshore Marine), and by study status (Historical Studies, Current Studies, Unfunded Studies). Current and historical studies could be evaluated and placed within the matrix according to the habitat and the contaminants monitored. A list of critical unfunded studies could then be developed and prioritized without duplicating previous or ongoing efforts.

Contaminants were broadly categorized as trace metal/elements, persistent organic pollutants, hydrocarbons/petroleum products, and radionuclides. More details can and should follow regarding which elements or compounds within these categories should be monitored on a regular basis, what methods should be used for sample collection and analysis, and what level of quality assurance/quality control is necessary to provide good data of known quality.

There was some discussion of the Arctic Monitoring and Assessment Programme (AMAP), an international monitoring program framework developed by all the Arctic nations. A summary of potential AMAP species was presented, and there was discussion about species important within the Bering Sea that do not appear on the AMAP list (Table 2). The group recognized that there will need to be involvement from a larger group before a final or official list of indicators is adopted. This initial list, however, may serve as a basis for consideration, giving others a starting point to work from. The AMAP indicators presented in the table are currently in draft form and may change. It also was noted that there has been a recent attempt to begin a systematic program to sample and monitor contaminant compounds in key marine mammal and, more recently, sea bird species through the Alaska Marine Mammal Tissue Archival Project (AMMTAP). In addition, the International Whaling Commission recently strengthened its commitment to research on environmental changes and the effects on cetaceans. In particular at its 1998 meeting, the Commission reiterated its support for two major collaborative research initiatives made by its Scientific Committee with respect to (1) chemical pollutants and (2) baleen whale habitat and prey studies. This commitment was shown by a proposal to establish a major research fund for environmental research to be considered next year (1999). In the Bering Sea and the Arctic, the IWC is expected to focus on bowhead whales; additional interest has been expressed for future studies of beluga whales and ice seals. Various agencies also have been conducting contaminants studies in the Bering Sea (including the U.S. Fish and Wildlife Service, National Marine Fisheries Service, and the Biological Resources Division of the U.S. Geological Survey). These efforts need to be included in any larger assessment.

It is recommended that sampling efforts in the Bering Sea include monitoring of a group of key species, the selection of which would be developed through a consensus approach designed to take advantage of existing or planned programs (e.g., AMMTAP, IWC, other agency monitoring programs, and perhaps AMAP) to avoid duplication and promote maximum sampling efficiency.

Some potential monitoring sites were also discussed by the group (Table 3). These were primarily areas where various agencies or local communities are currently conducting ecological or contaminants studies. Linking contaminants data collection efforts into existing studies looking at animal health or population trends should maximize the information gathered from any given site. This should also help us answer questions about biological effects or ecological relevance when we observe contamination in a species at a particular location. Maintaining current contaminants monitoring stations or revisit historic sites to investigate trends should also be priorities.

The group noted that to assess the impact of contaminants to key species, detailed life history, animal health and population dynamics studies need to be conducted concurrently. These long-term monitoring studies should be covered in depth in a comprehensive Bering Sea Science Plan, with ecological, health and contaminants aspects integrated in a coordinated approach. To date much of this basic monitoring remains largely unfunded even for key subsistence and commercial species.

A final recommendation is that a separate "Contaminants" workshop be held to discuss these details and get a broader group to endorse any recommendations. The introduced species issues and trash/debris issues also deserve their own forum, and the participants interested in these topics may differ from the "contaminants" group.

Subsistence Use and Human Health Issues

Human health and the levels of contamination in subsistence foods was a major topic of discussion. At first this was a separate column in the matrix (i.e., Table 1), then it was pointed out that humans might fit as a key "species" in this matrix, if it is adopted. Appropriate experts from the human health arena were not present in this group, so we were limited in the recommendations we can make. It was noted that dietary studies of subsistence users are lacking in approximately 25 Bering Sea villages. These need to be conducted soon, to help determine what species need to be monitored for contaminants, and to help agencies know which villages to contact should there be contamination found in a given species.

Local Knowledge and Wisdom

Concerns were expressed that Native Alaskan issues were not included in the Science Plan, nor were the proper people here at this meeting to make decisions and recommendations on what was being proposed. People living on or near the Bering Sea need to have their community needs reflected in any actions taken, and they should have input into the scientific approach used.

Also, there have been a number of meetings held by Alaskan Natives in the past several years discussing these very issues and the findings or recommendations coming out of these meetings have not been incorporated into the Bering Sea efforts to date. Future efforts should integrate these recommendations.

It was also recognized that local knowledge and wisdom can be very instrumental in assessing animal health and condition and provide insights into species abundance and behavior. Local experts have been, and are expected to be, valuable sources of sample material and information. Contaminants data (tissue values) are more interpretable when an appropriate linkage to ecological knowledge and biological effects has been established.

Local community participation was also mentioned in conjunction with oil spill preparedness and response. Not only do communities have great interest in helping to protect their local environment, but it makes financial sense. This approach may help minimize mobilization costs and speed response for spills in remote locations.

Introduced Species

Existing text within the draft science plan focused on ballast water and introduction of marine organisms into the Bering Sea. A major element missing from this discussion is the exotic terrestrial species which have already been introduced in the Aleutian Islands. Some islands have been invaded by rats (e.g, from grounded vessels) and others have non-native fox populations. These introductions have negatively impacted nesting seabirds primarily due to predation on eggs and young. Eradication efforts have been conducted on some islands or are currently underway, and rat-response planning has been conducted to help minimize the likelihood of future introductions. These efforts have been led primarily by the Alaska Maritime National Wildlife Refuge (U.S. Fish and Wildlife Service). The are also some islands that have introduced caribou populations, bringing their own set of changes to affected islands.

Discussion of introduction of marine species should also recognize ongoing or planned U.S. Fish and Wildlife Service efforts in Prince William Sound and Cook Inlet to monitor and minimize introduction of exotics found in ballast water, which may serve as a model for consideration. Similar efforts for the Bering Sea have no current funding support. If such a program is established, Dutch Harbor might be one logical monitoring site. Introductions from Japanese or Russian vessels in the western Bering Sea may be problematical regardless of what actions are taken in the U.S. unless a joint program is initiated.

Trash and Debris

Trash and debris (including discarded fishing nets and gear) received the least amount of group discussion, even though it was recognized as a very real problem. There was discussion regarding the role and effectiveness of current regulations (e.g., the MARPOL Protocol and related U.S. law), however we did not have much expertise in this issue. One participant suggested that recent enforcement has been successful in the Bering Sea, resulting in less trash in the open seas and more in terrestrial landfills within the communities. Solutions to the problem seem to focus more on the enforcement of existing laws, rather than initiating a large monitoring program, which would be very difficult and expensive given the size of the Bering Sea.

Prioritization of Projects

Future actions include identification of data gaps and prioritization of unfunded studies to determine which should be funded. This need is not unique to the Contaminants group and we may want to refer this topic back to the Plenary group. For contaminants issues, some potential criteria for selecting study species or funding research projects would be:

- ♦ Special status (e.g., Endangered, threatened)
- ♦ Subsistence use and interest in the species by local community
- ♦ Indicator of "health" of the system, for a given trophic level or feeding guild
- ♦ Access and cost to sample (capitalize on "opportunities")

There was agreement that prioritization would not be a static, one-time exercise. An adaptive management approach was recommended. As data gaps are filled, they can be "checked off" and we could move on to other species or other issues. There should be a temporal component to the monitoring such that species are resampled at a given interval (every 5 or 10 years) to determine whether contaminant loads have changed through time.

Table 1. Proposed matrix for organizing contaminants projects that have been done in the past, are currently underway, or need to be done in the future.

	Historical Studies		Current Studies		Unfunded Studies	
	Species or matrix to be sampled	Contaminant(s)	Species or matrix to be sampled	Contaminant(s)	Species or matrix to be sampled	Contaminant(s)
Freshwater/Terrestrial						
Near-shore Marine						
Offshore Marine						

Table 2. Initial list of species and abiotic indicators that are likely to be of interest for contaminants monitoring in the Arctic. These indicators mostly reflect marine species and marine habitats, however a similar list has been developed by AMAP and could be developed for the Bering Sea coast as well.

Draft* AMAP species and abiotic indicators	**Other Bering Sea Species of Potential Interest**
Air, Precipitation, Snowpack	Steller Sea Lion
Sea Water	Northern Fur Seal
Marine Sediment Cores	Bearded Seal
Blue Mussel	Bowhead Whale
Sculpin species (four-horned sculpin)	Sea Otters
Glaucous Gull	Spectacled and/or Steller's eiders
Black Guillemot	Common murres
Kittiwakes	Emperor Geese
Eiders (Common Eider)	Harlequin Ducks
Ringed Seal	Oldsquaw
Walrus	Cormorants
Beluga	Benthic invertebrates
Polar Bear	Zooplankton and/or Phytoplankton
Human Health	

** AMAP indicators were derived from draft documents developed at the April 1998 AMAP Experts meeting held in Girdwood, AK . A definitive AMAP matrix has not yet been finalized.*

Table 3. List of potential long-term contaminants monitoring sites in or along Bering Sea. These sites represent areas where studies are currently being conducted on species of interest (mainly marine mammals or sea birds). Not all species would be monitored at each site, thus a matrix of sites and species should be developed in the future. Two potential sites in the Chukchi Sea and Arctic Ocean are also included for consideration.

Pribilof Islands
St. Matthew Island
St. Lawrence Island
Barrow (Arctic Ocean)
Point Lay (Chukchi Sea)
Little Diomede Island
Nome
Bluff
Cape Peirce
Round Island
Kasatochi Island and Koniuji Island
Aiktak Island
Buldir Island
Russian sites (western Bering Sea)

** Note: Site-specific studies addressing local contamination issues have been, and will continue to be, conducted within the Bering Sea as well. Several sites such as Adak and Amchitka Islands, will potentially be issues for many years to come.*

HABITAT

Co-chairs: Dan Boone and Joe Sullivan

Initially we had some difficulty focusing on the topic. Possibly because habitat is a difficult topic to discuss until placed in the context of a particular species, group of species or a habitat type; habitat, by itself, is too general. The discussion bounced back and forth from the very specific to the very general several times before we decided to approach the issue from the categories suggested in the outline - Retrospective, Monitoring, Modeling, and Process. The following is a summary of those interactions.

New questions and statements regarding the lack of data pertinent to understanding the dynamics of the Bering Sea Ecosystem:

- Evaluate and define critical habitat for Steller sea lions.
- What baseline habitat data are available and what is the potential for consolidation of this information?
- What are the biological hot spots/key features supporting biodiversity?
- Identify key ecological processes.
- What are the potential consequences of changes in human economic and demographics upon habitat of the Bering Sea region?
- Identify representative habitats for monitoring.
- What are the economic and political impacts to decisions regarding habitat?
- Consolidate habitat information and make available to managers/decision makers.
- Understanding the changing nature of both populations and essential habitats.
- Identify essential habitat for various life stages of key species.

Additional projects were also generated and evaluated by category for difficulty, duration and priority.

<u>Retrospective analyses</u>

- Use traditional knowledge to get distributions and abundance of information for single species, e.g. herring. Moderately difficult, 1-3 years, Mid level priority

- Analyze historical data to determine habitat factors influencing change in distribution, e.g. pollock & cold pool, Russian-American marine mammal harvest data. Easy, 1-3 years, Mid level to high priority.

<u>Monitoring</u>

- Monitor habitat of species important to subsistence. Easy, ??, High priority

- Monitor habitat of species about which little is known, e.g. steelhead (fresh water only). Easy to difficult, ??, Mid level to high priority

- Demonstration project of monitoring a single species using local communities. Easy, 3-5 years (as demo only), High priority

- Map habitat of key species, e.g. juvenile king crab. Easy, 1-3 years, High priority

- Monitoring the extent of specific habitats, e.g. spawning habitat forTogiak herring, kelp biomass, eelgrass area, walrus feeding area. Moderately difficult, ??, High priority

<u>Modeling</u>

- Modeling haulout numbers of walrus in Bristol Bay. Easy, 1- 3years, Low to medium priority

- Modeling changes in habitat to change in abundance - spatial and temporal. Moderately difficult, 1-3 years, High priority

<u>Process studies</u>

- Identify habitat for important species. Difficult, Long-term, High priority

- Evaluate mechanical effects of human actions on habitat, e.g. trawling on the sea floor. Moderate to difficult, 3-5 years, High priority.

CLOSING COMMENTS

LOH-LEE LOW, DEPUTY DIVISION DIRECTOR, ALASKA FISHERIES SCIENCE CENTER, NATIONAL MARINE FISHERIES SERVICE

What I would like to do is try to provide a general summary. We have had two days of discussions and I hope it has given you an opportunity to provide your views. But if you have not, you still have lots of chances. So I'd like to thank you for the time that you've spent these last two days. It's fair, at this point in time, for us, the organizing committee, to give you a sense of where we're taking this project. We do have a Bering Sea science plan in draft form. It is our intention to focus on improving this draft plan over the next few weeks.

The committee intends to deliver this Bering Sea science plan to our agencies, to the public and to any other user groups that are interested. There are important questions that have been raised through the breakout groups that met at this workshop and from the talks of Clarence Pautzke, Patricia Cochran, Larry Merculieff, Henry Huntington and others. These questions will be incorporated into the draft plan, along with some very basic issues that need to be addressed.

What are these issues? For example, Dr. Pautzke identified management versus science issues. From his management point of view, there are some central themes that are so important that you cannot ignore, and that's the issue of declining sea lions populations. Our organizing group will now go back and look at this and other issues to see what we should emphasize in our draft plan.

Traditional knowledge, TK! How do we incorporate TK into the draft plan? Despite difficulties in coalescing TK input, this plan must go on to incorporate TK input. Some speakers have suggested that the TK input take a parallel track as the traditional science plan. I suppose it would work. The TK input would be brought in line with the rest of the research plan later. We recognize that the Native groups need time to organize, meet, consolidate views, and articulate their priorities for the draft science plan. There is some very basic work that needs to be done that would involve the local community, Natives as well as others, to provide input into the plan. There are needs for some monitoring activities involving basic data collection at the community/local levels. These activities should proceed while the TK concept is being consolidated to be brought into the plan.

I realize time was short for breakout groups to discuss all of their issues at this workshop. Nonetheless, they have reported good progress. The Organizing Committee intends to incorporate the views of these breakout groups into the draft plan. There are several general issues that came through. For example, we need a clearer definition of our issues and their questions. There are at least two major issues -- what are the effects of climate and what are the effects of human actions on the Bering Sea ecosystem. We need to articulate our research plans to address these issues. There are thematic questions posed from each one of our five discussion groups. Four research themes came through -- monitoring, retrospective analysis, process studies, and modeling.

Monitoring is one of those activities that needs to proceed. We must monitor because we need to collect information for the future. There are some near-term problems that we can mitigate, but on a longer term basis, we must have foresight to collect the right type of information so that, maybe generations from now, we will answer the tough questions. Retrospective analysis comes through as a second thematic research theme. The next one is process studies. We need to understand the dynamics of events that are happening. Modeling comes through as the fourth research theme. There is need to use models to consolidate our views and to provide a holistic picture of the ecosystem to guide future work. Within each one of these four research themes, we must provide an assessment of the feasibility, duration, and priority of projects. The projects that have been discussed by our breakout groups must be important. The organizing committee will be identifying them for the draft.

Finally, the organizing committee intends to revise the Bering Sea science plan and send the draft out for peer review. What's our time schedule? As I understand it, it may be very short. The sooner we get started, the better, as there has been background talk of developing equivalent science plans for the Arctic and the Gulf of Alaska.

DEBORAH WILLIAMS, SPECIAL ASSISTANT TO THE SECRETARY FOR ALASKA, DEPARTMENT OF THE INTERIOR

Establishing goals is important for long-term and short-term research priorities, because there never will be enough money to fund all research needs. The four most important priorities are the ability to contribute to long-term predictions, ability to contribute to critical near-term management concerns, fit of the research with the vision, and cost effectiveness. Prioritization should make long-term predictions possible, and also contribute to critical near-term management concerns.

It is important to get new research funds. Research monies should be available from the Dinkum-Sands settlement through the North Pacific Research Board. There are some potential additional administrative initiatives. The most effective way to get new money is to draw attention to the region, because where there is attention and where there is interest, hopefully money will follow. So think and act creatively to generate more money. Let the entire country know the importance of this ecosystem. When people throughout the administration, the Congress, and the country know where the Bering Sea is, what marine ecosystem has the highest international/national congregation of migratory birds, what marine ecosystem has the highest congregation of marine mammals and know which marine ecosystem produces more fish for consumption than any other marine ecosystem in the United States, then we will get more research dollars.

At the same time, it is important to promote cost effectiveness. Recommendations were made to take advantage of some of the vehicles out in the Bering Sea, such as fishing vessels and Coast Guard icebreakers. Some groups recommended taking advantage of the people who live in Bering Sea coastal communities for information gathering and monitoring.

Good luck to the Organizing Committee in helping us prioritize because my hope is next year at this time we're going to have many new millions of dollars to work with and start applying to these priorities.

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